(11)Publication number : 2003-215613
(43)Date of publication of application : 30.07.2003

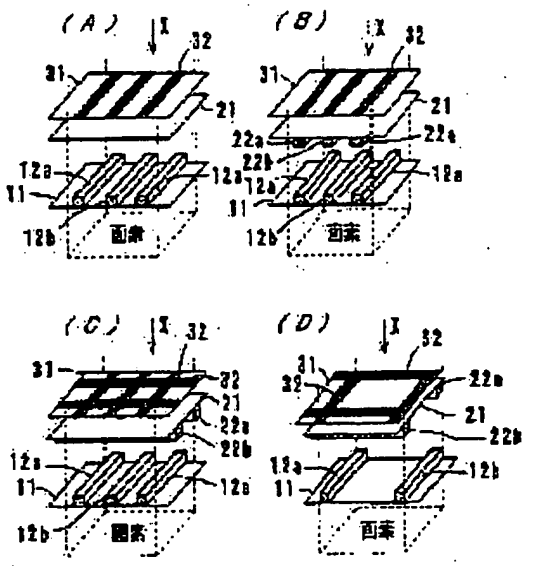
(51)Int.Cl. G02F 1/1343
G02F 1/137

(21)Application number : 2002-009224
(22)Date of filing : 17.01.2002

(71)Applicant : MINOLTA CO LTD
(72)Inventor : OCHI KEIZO

(54) LIQUID CRYSTAL DISPLAY ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a liquid crystal display element capable of eliminating deterioration in the picture quality as far as possible by constituting the element so that an unnecessary state o a liquid crystal, caused by a longitudinal electric field collaterally generated on the upper side of electrodes to apply a lateral electric field, does not affect the display.
SOLUTION: The liquid crystal display element displays a picture by holding the liquid crystal exhibiting a cholesteric phase between a pair of substrates 11, 21 applying the lateral (or longitudinal) electric field between the electrodes 12a, 12b and/or between the electrodes 22a, 22b and setting the liquid crystal in a focal conic state or in a planar state. Masking members 32 to cover the respective electrodes on the display screen side are arranged.



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]
* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The liquid crystal display component characterized by having a wrap mask member for the electrode for impressing the horizontal electric field of the direction along a substrate side which it was pinched between the substrate of a couple, and said substrate, and were prepared in the liquid crystal layer which shows the cholesteric phase which constitutes two or more pixels arranged in the shape of a matrix, and one [at least] substrate, and said electrode for horizontal electric-field impression by the screen side.
[Claim 2] It is the liquid crystal display component according to claim 1 which has the branching polar zone which said electrode for horizontal electric-field impression consisted of two or more electrodes, or branched to plurality, and is characterized by preparing said mask member corresponding to said two or more electrodes or each of the branching polar zone.
[Claim 3] It is the liquid crystal display component according to claim 1 which said electrode for horizontal electric-field impression has the part located in the boundary section of each pixel, and is characterized by preparing said mask member corresponding to the electrode section of this pixel boundary section.
[Claim 4] Said mask member is claim 1 characterized by being prepared on one substrate now put on the substrate by the side of the screen, or on a this substrate observation-side, and a liquid crystal display component according to claim 2 or 3.
[Claim 5] Claim 1 which two or more laminatings of the liquid crystal layer pinched between said substrates are carried out, and is characterized by preparing a mask member on one substrate now which was put on the substrate by the side of the screen, or on the screen side of this substrate among the substrates which pinch this liquid crystal layer about at least one liquid crystal layer, claim 2, a liquid crystal display component according to claim 3 or 4.

[Translation done.]

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the liquid crystal display component which pinches a liquid crystal display component and the liquid crystal in which a cholesteric phase is

shown, and displays between the substrates of a couple especially using the selective reflection of this liquid crystal.
[0002]
[Description of the Prior Art] Conventionally, the chiral nematic liquid crystal in which cholesteric liquid crystal and a cholesteric-liquid-crystal phase are shown is pinched between the substrates of a couple, parallel horizontal electric field are impressed to a substrate side, and the liquid crystal display component which displays by changing the condition of liquid crystal is proposed (for example, refer to JP,7-120792,A and JP,2001-83485,A). There is also an example which superimposes vertical electric field at the time of impression of horizontal electric field (refer to JP,2001-100256,A).
[0003] By the way, in the conventional typical liquid crystal display component using the liquid crystal in which the cholesteric-liquid-crystal phase which the condition (a focal conic condition, planar condition) of liquid crystal is changed, and displays an image by impression of horizontal electric field is shown, in order to generate horizontal electric field independently for every pixel, as shown in drawing 11 , the electrodes 12a and 12b arranged at one [at least] substrate 11 were made into the shape of a ctenidium.
[0004] Although the horizontal electric field E1 occurred when the potential difference was produced between electrode 12a of the shape of this ctenidium, and 12b, the trouble of vertical vertical electric-field E2' having occurred subordinately to a substrate side above Electrodes 12a and 12b, and spoiling the quality of a display image was produced. For example, when the helical shaft had set the liquid crystal between electrode 12a and 12b to a focal conic condition parallel to a substrate side by the horizontal electric field E1, on electrode 12a and 12b, liquid crystal could not be set to the focal conic condition, but the unnecessary echo occurred and it had had an adverse effect on image quality -- contrast falls.
[0005] Then, the object of this invention is to offer the liquid crystal display component for which it can eliminate degradation of image quality as much as possible as the unnecessary condition of the liquid crystal by the vertical electric field subordinately generated above the electrode for impressing horizontal electric field does not contribute to a display.
[0006]
[The configuration, an operation, and effectiveness] of invention In order to attain the above object, the liquid crystal display component concerning this invention The liquid crystal layer which shows the cholesteric phase which constitutes two or more pixels which were pinched between the substrate of a couple, and this substrate and have been arranged in the shape of a matrix, It is characterized by having a wrap mask member for the electrode for impressing the horizontal electric field of the direction along a substrate side prepared in one [at least] substrate, and this electrode for horizontal electric-field impression by the screen side.
[0007] In the liquid crystal display component concerning this invention, since the electrode for horizontal electric-field impression is covered by the mask member, a condition unnecessary to the display by the vertical electric field subordinately generated on this electrode is not observed by the screen side, and degradation of image quality is prevented.
[0008] In the liquid crystal display component concerning this invention, although it should have the branching polar zone which constituted the electrode for horizontal electric-field impression from two or more electrodes, or branched to plurality and said mask member may be prepared corresponding to said two or more electrodes or each of the branching polar zone, corresponding to no electrodes for horizontal electric-field impression, it not necessarily needs to be prepared. Moreover, it should have the electrode section located in the boundary section of each pixel in the electrode for horizontal electric-field impression, and a mask member may be prepared corresponding to this electrode section. After preparing the electrode for horizontal electric-field impression only in the boundary section of each pixel, a mask member may be prepared corresponding to the electrode for horizontal electric-field impression prepared in this boundary section.
[0009] Degradation of image quality can be effectively prevented by preparing a mask member, but on the other hand since a screen numerical aperture falls, display brightness will fall a little. Therefore, what is necessary is just to select the electrode for horizontal electric-field

impression which carries out comparison consideration of degradation of image quality, and the brightness of a screen, and prepares a mask member. Moreover, if a mask member is prepared corresponding to the electrode for horizontal electric-field impression located in the boundary section of each pixel, the effectiveness of separating a pixel in image display will be demonstrated, a blot of a color, dotage of the edge section, etc. will be canceled, and a sharp image will be obtained.

[0010] Moreover, the width of face of a mask member may be in agreement with the width of face of the electrode for horizontal electric-field impression, or it may be larger than the width of face of the electrode for horizontal electric-field impression, or it may be narrow. The direction of the electric field by the electrode for horizontal electric-field impression is not uniform in the field where electric field become length depending on electrode width of face and an electrode spacing. If the field which should cover the unnecessary condition by the vertical electric field generated subordinately may be in agreement with electrode width of face, it may be larger than electrode width of face, and just covers the narrow range conversely. Therefore, what is necessary is just to determine the width of face of a mask member according to this field that should be covered. Furthermore, the width of face of a mask member also takes relation with display brightness into consideration, and is decided.

[0011] Furthermore, a mask member may be prepared on one substrate now which could prepare in the substrate by the side of the screen, or was put on the substrate by the side of the screen. When an electrode is prepared in the substrate by the side of the screen, this electrode may serve as the mask member. That is, a mask member can be made to make it serve a double purpose by making an electrode opaque (for example, black).

[0012] The laminating of two or more liquid crystal layers by which each was pinched between the substrates of a couple is carried out, and you may make it prepare a mask member on one substrate now which was put on the substrate by the side of the screen, or on the screen side of this substrate among the substrates which pinch this liquid crystal layer about at least one liquid crystal layer. In this case, it is desirable to prepare a mask member on one substrate now which was put on the substrate by the side of the screen of the substrate which pinches the liquid crystal layer most located in a screen side at least, or on the screen side of this substrate. If it does in this way, it will become possible to perform a mask about all liquid crystal layers by the mask member most prepared in the screen side of the liquid crystal layer by the side of the screen.

[0013]

[Embodiment of the Invention] Hereafter, the operation gestalt of the liquid crystal display component concerning this invention is explained with reference to an accompanying drawing.

[0014] (Refer to an actuation principle and drawing 1) The liquid crystal display component concerning this invention displays based on various actuation principles, and explains the horizontal electric-field 2 cycle actuation method which is one of an in-every-direction electric-field change method and the IPS (In-Plane-Switching) methods as the typical actuation principle.

[0015] An in-every-direction electric-field change method is equipped with a means to impress the means and horizontal electric field which impress vertical electric field, and there is with solution Lycium chinense about torsion of the liquid crystal (it represents with a chiral nematic liquid crystal hereafter) in which a cholesteric phase is shown by both switch, to a substrate, preferably, to a substrate, it displays by making it change to parallel mostly, and halftone expresses [almost vertical and] the helical shaft by the area gradation method at a predetermined include angle. [no] On the other hand, there is also a method which leans a helical shaft to the include angle of arbitration with the combination of electric field in every direction.

[0016] A chiral nematic liquid crystal is obtained by adding the chiral material of the specified quantity to a nematic liquid crystal. As shown in drawing 1 (A), generally as for this chiral nematic liquid crystal, the rod-like liquid crystal molecule shows nothing and a cholesteric phase for the distorted array. When light carried out incidence to this liquid crystal and light carries out incidence from an parallel direction to a helical shaft, selective reflection of the light of the

wavelength shown by lambda=np is carried out (planar condition). Here, lambda is the distance (it is hereafter described as a spiral pitch) in which wavelength and n can twist the average refractive index of a liquid crystal molecule, and p has twisted 360 degrees of liquid crystal molecules. On the other hand, when light carries out incidence from a vertical direction to a helical shaft, light is penetrated theoretically (focal conic condition). A display is performed using this selective reflection and transparency. In addition, the cholesteric phase of liquid crystal is shown also like drawing 1 (B).

[0017] By the way, although the liquid crystal molecule is cylindrical, it has the anisotropy from which a refractive index and a dielectric constant differ in the longitudinal direction (major axis) and a direction (minor axis) vertical to it. A dielectric constant anisotropy calls liquid crystal with the larger dielectric constant of the direction of a major axis of a liquid crystal molecule than that of the direction of a minor axis forward liquid crystal. If a dielectric constant anisotropy impresses an electrical potential difference high enough to forward liquid crystal, torsion will be cleared, and it moves so that the major axis (shaft with a large dielectric constant) of a liquid crystal molecule may be suitable in the direction parallel to the direction of electric field. A threshold exists in the electrical potential difference which this torsion solves, and this threshold voltage is set to Vh.

[0018] Moreover, if an electrical potential difference lower than said threshold voltage Vh is impressed to liquid crystal, liquid crystal will move so that there may be nothing with solution Lycium chinense about torsion and a helical shaft may be suitable in the vertical direction to the direction of electric field. A threshold exists also in the electrical potential difference to which this helical shaft is moved, and this threshold voltage is set to Vf.

[0019] The relation of such threshold voltage Vh and Vf is Vf<Vh. Moreover, even if it impresses an electrical potential difference lower than threshold voltage Vf to liquid crystal, a liquid crystal molecule does not move, namely, helical shaft orientations do not change.

[0020] On the other hand, a dielectric constant anisotropy calls liquid crystal with the dielectric constant of the direction of a major axis of a liquid crystal molecule smaller than that of the direction of a minor axis negative liquid crystal. If a dielectric constant anisotropy impresses an electrical potential difference high enough to negative liquid crystal, there will be nothing with solution Lycium chinense about torsion, and a helical shaft will turn to the direction of electric field at random not related. This phenomenon is called dynamic scattering. A threshold exists in the electrical potential difference to which this phenomenon happens, and threshold voltage is set to Vd.

[0021] Moreover, if an electrical potential difference lower than said threshold voltage Vd is impressed to liquid crystal, liquid crystal will move so that there may be nothing with solution Lycium chinense about torsion and a helical shaft may be suitable in the parallel direction to the direction of electric field. A threshold exists also in the electrical potential difference to which this helical shaft is moved, and this threshold voltage is set to ****.

[0022] The relation of such threshold voltage Vd and **** is ****<Vd. Moreover, even if it impresses an electrical potential difference lower than threshold voltage **** to liquid crystal, a liquid crystal molecule does not move, namely, helical shaft orientations do not change.

[0023] In addition, generally the direction of liquid crystal in which a cholesteric phase is shown of the anisotropy of a refractive index and the anisotropy of a dielectric constant over the shaft of a liquid crystal molecule corresponds; and in liquid crystal forward in a dielectric constant anisotropy, the refractive index of the direction of a major axis of a liquid crystal molecule is larger than that of the direction of a minor axis, and it is common in liquid crystal negative in a dielectric constant anisotropy for the refractive index of the direction of a major axis of a liquid crystal molecule to be smaller than that of the direction of a minor axis.

[0024] On the other hand, an IPS method is a method which displays by impressing parallel horizontal electric field to a substrate, and explains a horizontal electric-field 2 cycle actuation method as an example.

[0025] That is, when the liquid crystal of a certain kind in which a cholesteric phase is shown switches the frequency of impression electric field to a RF/low frequency, that from which forward/negative one of a dielectric constant anisotropy switch exists. By switching the

frequency to a RF and low frequency to such liquid crystal, even if applied voltage is only horizontal electric field, spiral structure can carry out the frog thing of the sense of the helical shaft nothing with solution Lycium chinense thoroughly, each pixel can be selectively set to a focal conic condition or a planar condition, and an image can be displayed.

[0026] In addition, what (that is, it considers as the display device which has memory nature) is also constituted so that after an electrical-potential-difference impression halt can maintain a display condition is possible by using the liquid crystal in which cholesteric phases, such as a chiral pneumatic liquid crystal, are shown. In the case of the display device which has memory nature, a predetermined time still picture is displayed using the memory nature of a component in many cases. Since a still picture is considered that an irregular color is easy to be checked by looking compared with an animation, especially its application of this invention is effective.

[0027] (Refer to the 1st operation gestalt, drawing 2 , and drawing 3) The liquid crystal display component which is the 1st operation gestalt is based on said horizontal electric-field 2 cycle actuation method, and shows the typical examples 1, 2, 3, and 4 of an electrode configuration to drawing 2 (A), (B), (C), and (D). In addition, in each component shown in drawing 2 , an image will be observed from arrow-head X, respectively.

[0028] The example 1 of a configuration forms the electrodes 12a and 12b for horizontal electric-field impression in the top-face side of the bottom substrate 11, as shown in drawing 2 (A), and the electrode is not prepared in the top substrate 21. Moreover, one substrate 31 puts on the top face of the top substrate 21 now, and Electrodes 12a and 12b are formed in the mask member 32 by the wrap location by the screen side on the top face of this substrate 31.

[0029] In addition, the electrode for horizontal electric-field impression may consist of two or more electrodes, may form one electrode in the shape of a ctenidium, for example, and may branch two or more branching polar zone. This point is the same also about the examples 2-8 of a configuration mentioned later.

[0030] Among substrates 11 and 21, the liquid crystal in which a cholesteric phase is shown is pinched. As this kind of liquid crystal, if a room temperature shows a cholesteric phase, various things can be used. Typically, chiral material is added to a nematic liquid crystal, and the chiral nematic liquid crystal in which the cholesteric-liquid-crystal phase was shown at the room temperature is used. When the liquid crystal used with this 1st operation gestalt switches the frequency of the electric field impressed to Electrodes 12a and 12b to a RF/low frequency, forward/negative one of a dielectric constant anisotropy switch.

[0031] in order to hold the gap between a substrate 11 and 21 uniformly and uniformly -- the need -- responding -- the particle for spacers to between a substrate 11 and 21 -- the resin structure of the shape of pillar-shaped or a wall is arranged. Moreover, the optical absorption layer which absorbs the light is prepared in the rear face of the lower substrate 11. A light absorption function may be given to substrate 11 the very thing. Furthermore, the orientation control film and/or an insulator layer may be formed in the field which touches the liquid crystal layer of substrates 11 and 21.

[0032] Various things, such as plastic films, such as glass, polyether sulfone, polyethylene terephthalate, and a polycarbonate, can be used for the ingredient of substrates 11, 21, and 31. A lightweight and thin thing is desirable. Transparent electrode ingredients, such as ITO and IZO, can be used for the ingredient of an electrode, and the electrodes 12a and 12b of the bottom substrate 11 may use non-transparent electrode ingredients, such as aluminum and Cu. Electrodes 12a and 12b may be arranged to two steps through an insulator layer (not shown).

[0033] The ingredient of the mask member 32 has [that what is necessary is just what can form the film which has protection-from-light nature] the dark color and the desirable thing which can form the black film especially from a viewpoint of contrast lowering prevention. For example, resin film, black photosensitivity resist film, etc. which come to distribute protection-from-light agents, such as a cascade screen of metal metallurgy group oxide film, such as chromium, nickel, aluminum, and a tungsten, said metal membrane, and said metallic-oxide film, carbon, and titanium, in resin, such as acrylic resin, can be used. A mask member may consist of ingredients of a thing or light reflex nature which have colors other than black according to liking of an observer etc.

[0034] the case where the metal metallurgy group oxide film is used -- FOTORISO -- the mask member of a request pattern can be formed by the approach of etching in the shape of a pattern using law etc. When using the resin film which distributed the protection-from-light agent, the mask member of a request pattern can be formed by the approach of printing to a predetermined pattern by print processes, such as the ink jet method. the case where the black photosensitivity resist film is used -- FOTORISO -- the mask member of a request pattern can be formed by removing a garbage by law.
[0035] In the example 1 of a configuration, if a polar electrical potential difference which is different in Electrodes 12a and 12b is impressed, for example, the horizontal electric field E1 of low frequency are generated so that it may be shown for drawing 3 (A) and (not illustrating a substrate 31 by drawing 3 for simplification), liquid crystal negative in a dielectric constant anisotropy will be in the FOKARUKONIKKU condition that the helical shaft turns to the same direction as the horizontal electric field E1. However, since only vertical electric-field E2' is generated on electrode 12a and 12b, the liquid crystal of this field will be in the planar condition that a helical shaft turns to the same direction as vertical electric-field E2'.
[0036] It will be in the planar condition which turns to solution Lycium chinense and the direction where a helical shaft is vertical to the horizontal electric field E1 nothing for spiral structure thoroughly as, as for this liquid crystal, a dielectric constant anisotropy just changes on the other hand if the side electric field E1 of a RF are generated among electrode 12a and 12b, and shown in drawing 3 (B). However, since only vertical electric-field E2' is generated on electrode 12a and 12b, the liquid crystal of this field will be in the focal conic condition that a helical shaft turns to a direction vertical to vertical electric-field E2'.
[0037] Thus, in the upper part of Electrodes 12a and 12b, since only vertical electric-field E2' is generated, with the liquid crystal which constitutes the pixel between electrode 12a and 12b, it will be in the condition of reverse, and if this is reflected in the screen, image quality will be degraded. In the example 1 of a configuration, since the field on electrode 12a which degrades image quality, and 12b is covered by the mask member 32, with a pixel, the field in the condition of reverse is covered to an observer, and degradation of image quality is prevented.
[0038] The example 2 of a configuration forms Electrodes 22a and 22b in the electrodes 12a and 12b of the bottom substrate 11, and the location which countered also at the underside side of the top substrate 21, as shown in drawing 2 (B). Other configurations, the mode which drives liquid crystal by the horizontal electric-field 2 cycle actuation method, and the operation effectiveness of the mask member 32 are the same as that of said example 1 of a configuration.
[0039] The example 3 of a configuration forms Electrodes 22a and 22b in the direction which intersects perpendicularly with the electrodes 12a and 12b of the bottom substrate 11 at the underside side of the top substrate 21, as shown in drawing 2 (C). The mask member 32 is formed so that each of Electrodes 12a, 12b, 22a, and 22b may be covered. Other configurations, the mode which drives liquid crystal by the horizontal electric-field 2 cycle actuation method, and the operation effectiveness of the mask member 32 are the same as that of said example 1 of a configuration.
[0040] In addition, in drawing 2 (A) - (C), although the number of the electrode arranged in a pixel is made into 2-3 in order to make an understanding easy, this number is arbitrary and good also as three or more.
[0041] The example 4 of a configuration forms the electrodes 12a, 12b, 22a, and 22b which intersect perpendicularly with the top-face [of the bottom substrate 11], and underside side of the top substrate 21 mutually only in the boundary section of a pixel, as shown in drawing 2 (D). The mask member 32 is formed so that each of Electrodes 12a, 12b, 22a, and 22b may be covered. Other configurations, the mode which drives liquid crystal by the horizontal electric-field 2 cycle actuation method, and the operation effectiveness of the mask member 32 are the same as that of said example 1 of a configuration.
[0042] Especially, in the example 4 of a configuration, since Electrodes 12a, 12b, 22a, and 22b were installed in the boundary section of each pixel and the mask member 32 was formed corresponding to these electrodes, the effectiveness of separating a pixel in image display is demonstrated, a blot of a color, dotage of the edge section, etc. are canceled, and a sharp image

is obtained. Moreover, the degree to which display brightness falls by the mask member 32 decreases.

[0043] In addition, in the examples 2-4 of a configuration, although horizontal electric field can be made to act on the electrodes 22a and 22b prepared on the top substrate 21 more effectively to a liquid crystal layer by impressing the electrical potential difference which generates horizontal electric field, it is also possible to display by not impressing an electrical potential difference to Electrodes 22a and 22b, but impressing an electrical potential difference only to the electrode on the bottom substrate 11.

[0044] (Refer to the 2nd operation gestalt, drawing 4 - drawing 6) The liquid crystal display component which is the 2nd operation gestalt is based on said in-every-direction electric-field change method, and shows the typical examples 5, 6, 7, and 8 of an electrode configuration to drawing 4 (A), (B), (C), and (D). In addition, in each component shown in drawing 4 , an image will be observed from arrow-head X, respectively.

[0045] As shown in drawing 4 (A), the example 5 of a configuration makes the electrodes 12a, 12b, 22a, and 22b for impressing vertical electric field and horizontal electric field counter mutually, and is prepared in the underside side of the top-face side of the bottom substrate 11, and the top substrate 21. Electrodes 12a, 12b, 22a, and 22b are formed in the wrap mask member 32 by the screen side now which was prepared in the top face of the top substrate 21 in piles on the top face of one substrate 31.

[0046] The chiral nematic liquid crystal which, as for a substrate 11 and the liquid crystal in which the cholesteric phase pinched among 21 is shown, a dielectric constant anisotropy shows negative or forward is used. By impressing selectively horizontal electric field or vertical electric field, that helical shaft turns to a predetermined direction, and the liquid crystal used with this 2nd operation gestalt will be in a focal conic condition or a planar condition, and will display an image.

[0047] In addition, construction material, the formation approach, etc. of substrates 11, 21, and 31 or the mask member 32 are the same as that of what was explained with said 1st operation gestalt.

[0048] If it is in the chiral nematic liquid crystal which has a negative dielectric constant anisotropy in the example 5 of a configuration if it drives so that the electrical-potential-difference difference more than **** may be produced among the electrodes 12a and 12b prepared in the substrate 11 lower than Vd (the need — responding — between Electrodes 22a and 22b) in order to move so that the helical shaft may be parallel to the direction of electric field The horizontal electric field E1 parallel to a substrate side occur, and liquid crystal will be in the focal conic condition that the helical shaft is suitable in the direction almost parallel to a substrate side so that it may be shown for drawing 5 (A) and (not illustrating a substrate 31 by drawing 5 and drawing 6 for simplification). However, since only vertical electric-field E2' is generated on electrode 12a and 12b, the liquid crystal of this field will be in the planar condition that a helical shaft turns to the same direction as vertical electric-field E2'.

[0049] It will be in the planar condition which is suitable in the direction where the length electric field E2 vertical to a substrate side will occur if it drives so that the electrical-potential-difference difference more than **** may be produced lower between Electrodes 12a and 22a and between Electrodes 12b and 22b than Vd, as shown in drawing 5 (B) on the other hand, and the helical shaft of liquid crystal is vertical to a substrate side. Moreover, vertical electric-field E2' occurs also on electrode 12a and 12b, and the liquid crystal of this field will also be in a planar condition.

[0050] Moreover, if it is in the chiral nematic liquid crystal which has a forward dielectric constant anisotropy If it drives so that the electrical-potential-difference difference more than Vf may be produced lower than Vh among Electrodes 12a and 22a and among Electrodes 12b and 22b in order to move so that the helical shaft may become vertical to the direction of electric field, as shown in drawing 6 (A) The vertical electric field E2 vertical to a substrate side occur, and liquid crystal will be in the sense and a focal conic condition in the direction where the helical shaft is parallel to a substrate side. Moreover, vertical electric-field E2' occurs also on electrode 12a and 12b, and the liquid crystal of this field will also be in a focal conic condition.

[0051] if it drives so that the electrical-potential-difference difference more than Vf may be produced among Electrodes 12a and 12b on the other hand lower than Vh (the need -- responding -- between Electrodes 22a and 22b), the horizontal electric field E1 parallel to a substrate side occur, and liquid crystal will be in the sense and a planar condition in the direction where the helical shaft is almost vertical to a substrate side. However, since only vertical electric-field E2' is generated on electrode 12a and 12b, the liquid crystal of this field will be in the focal conic condition that a helical shaft turns to a direction vertical to vertical electric-field E2'.

[0052] Thus, in the upper part of Electrodes 12a and 12b, since only vertical electric-field E2' is generated, if a dielectric constant anisotropy is in negative liquid crystal, it is fixed to a planar condition, and if a dielectric constant anisotropy is in forward liquid crystal, it is fixed to a focal conic condition. That is, the upper liquid crystal of Electrodes 12a and 12b cannot control the condition, but degrades image quality. In the example 5 of a configuration, since the field on electrode 12a which degrades image quality, and 12b is covered by the mask member 32, with a pixel, the field in the condition of reverse is covered to an observer, and degradation of image quality is prevented.

[0053] The example 6 of a configuration forms the electrode 23 of the shape of a field corresponding to the whole surface of a pixel in the top substrate 21 to the electrodes 12a and 12b on the bottom substrate 11, as shown in drawing 4 (B). Other configurations and the dielectric constant anisotropy of the mode which drives forward or negative liquid crystal by the in-every-direction electric-field change method, and the operation effectiveness of the mask member 32 are the same as said example 5 of a configuration.

[0054] The example 7 of a configuration forms Electrodes 22a and 22b in the direction which intersects perpendicularly with the electrodes 12a and 12b of the bottom substrate 11 at the underside side of the top substrate 21, as shown in drawing 4 (C). The mask member 32 is formed so that each of Electrodes 12a, 12b, 22a, and 22b may be covered. Other configurations and the dielectric constant anisotropy of the mode which drives forward or negative liquid crystal by the in-every-direction electric-field change method, and the operation effectiveness of the mask member 32 are the same as said example 5 of a configuration.

[0055] In addition, in drawing 4 (A) - (C), although the number of the electrodes 12 and 22 arranged in a pixel is made into 2-3 in order to make an understanding easy, this number is arbitrary and good also as three or more.

[0056] The example 8 of a configuration forms the electrodes 12a, 12b, 22a, and 22b which intersect perpendicularly with the top-face [of the bottom substrate 11], and underside side of the top substrate 21 mutually only in the boundary section of a pixel, as shown in drawing 4 (D). The mask member 32 is formed so that each of Electrodes 12a, 12b, 22a, and 22b may be covered. Other configurations and the dielectric constant anisotropy of the mode which drives forward or negative liquid crystal by the in-every-direction electric-field change method, and the operation effectiveness of the mask member 32 are the same as said example 5 of a configuration. Moreover, the operation effectiveness by carrying out the mask of the boundary section of each pixel is as said example 4 of a configuration having explained.

[0057] (Refer to the installation location of a mask member, and drawing 7) Here, the installation location of the mask member 32 is explained. If it was in said examples 1-8 of a configuration, the example in which the mask member 32 was formed was shown in the substrate 31 formed in the top face of the top substrate 21 in piles. Drawing 7 (A) may show the cross-section configuration of the example 1 of a configuration, and may form the mask member 32 in an underside besides forming in the top face of a substrate 31.

[0058] Moreover, the mask member 32 may be directly formed in the top-face side of the top substrate 21 (refer to drawing 7 (B)). Or the mask member 32 may be formed in the underside side of the top substrate 21, and Electrodes 22a and 22b may be formed in piles on it (refer to drawing 7 (C)). Or it is good also as what colored the electrodes 22a and 22b formed in the top substrate 21 black so that it might have an opaque thing, for example, an optical absorption function, (refer to drawing 7 (D)).

[0059] In addition, the mask member 32 needs to be installed corresponding to no electrodes. For example, in said examples 1, 2, 3, 5, 6, and 7 of a configuration, one of three mask members 32 juxtaposed to 1 pixel of a center may be omitted. In this case, priority is made given to display brightness.
[0060] (Refer to the width of face of a mask member, drawing 8 , and drawing 9) Next, the relation between the width of face of a mask member and the width of face of an electrode is explained. What is necessary is just to make the width method of the mask member 32 in agreement with the width method of electrodes 12 and 22 generally (refer to drawing 8 (A)). However, the field which vertical electric-field E2' generates is not uniform depending on electrode width of face and an electrode spacing. therefore -- setting up the width method of the mask member 32 more greatly than the width method of electrodes 12 and 22 **** -- (the drawing 8 (B) reference) -- you may set up small (refer to drawing 8 (C)).
[0061] Furthermore, the mask member 32 may set up the width method of the mask member 32 narrowly in consideration of relation with display brightness, in order to invite lowering of display brightness.
[0062] Like said examples 4 and 8 of a configuration, as Electrodes 12a, 12b, 22a, and 22b are indicated to be the cases where it uses in common to actuation of a contiguity pixel as the configuration which forms Electrodes 12a, 12b, 22a, and 22b in the boundary section of a pixel shows to drawing 9 (A) to drawing 9 (B), it may prepare for every pixel. In addition, the field which attached the slash in drawing 9 (A) and (B) shows 1 pixel.
[0063] In the configuration which shares the electrode shown in drawing 9 (A), the width method of a mask member is determined on the basis of the width method D1 of each electrode. It may be narrow when large [, and]. What is necessary is just to determine the width method of a mask member in the configuration which made the electrode shown in drawing 9 (B) become independent on the basis of the width method D2 including an adjoining electrode and a field in the meantime. That is, a mask member will cover electrodes including the field between pixels.
[0064] (Refer to the 3rd operation gestalt and drawing 10) Drawing 10 (A) is the important section sectional view of the laminating mold liquid crystal display component which carried out the laminating of two or more liquid crystal display components. The laminating of the three display devices which perform selective reflection of B (blue), G (green), and R (red) sequentially from an observer side in this display device is carried out through the adhesives layer 41, and a full color display is possible. In drawing 10 (A), the mask member 32 is allotted only on the component which performs selective reflection of B arranged most at an observation side. If it does in this way, the effectiveness of a mask can be done about all liquid crystal layers by the mask member 32 most prepared in B by the side of the screen, and a configuration is easy.
[0065] Drawing 10 (B) is the example which formed the mask member 32 in each component, respectively in a laminating mold liquid crystal display component. Even if the laminating of a component shifts in a manufacture process, the display degradation part by this gap does not arise. You may make it serve as the mask member of a bottom component by making opaque the electrode on the bottom substrate of an upside component.
[0066] In addition, the laminating gestalt of a component can adopt not only the aforementioned thing but various gestalten. For example, what carried out the laminating of the display device which may carry out the laminating of the four or more components, and performs selective reflection of the wavelength of arbitration to two-layer may be used.
[0067] (Other operation gestalten) in addition, the liquid crystal display component concerning this invention is not limited to said each operation gestalt, within the limits of the summary, can be boiled variously and can be changed.
[0068] Although the liquid crystal display component of a passive-matrix mold is especially mentioned as the example with said operation gestalt, this invention is applicable if it displays by generating horizontal electric field also in the liquid crystal display component of the active-matrix mold which has a switching element (for example, TFT:Thin Film Transistor and TFD:Thin Film Diode) for every pixel.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The explanatory view showing the principle of operation of liquid crystal.
[Drawing 2] The perspective view showing the examples 1-4 of an electrode configuration of the liquid crystal display component which is the 1st operation gestalt.
[Drawing 3] In the explanatory view of the liquid crystal in said example 1 of a configuration of operation, (A) shows the case where (B) chooses a planar condition, when a focal conic condition is chosen.
[Drawing 4] The perspective view showing the examples 5-8 of an electrode configuration of the liquid crystal display component which is the 2nd operation gestalt.
[Drawing 5] In the explanatory view of the liquid crystal which has a negative dielectric constant anisotropy in said example 5 of a configuration of operation, (A) shows the case where (B) chooses a planar condition, when a focal conic condition is chosen.
[Drawing 6] In the explanatory view of the liquid crystal which has a forward dielectric constant anisotropy in said example 5 of a configuration of operation, (A) shows the case where (B) chooses a planar condition, when a focal conic condition is chosen.
[Drawing 7] The explanatory view showing the installation location (four kinds) of a mask member.
[Drawing 8] The explanatory view showing the relation (three kinds) between the width of face of a mask member, and the width of face of an electrode.
[Drawing 9] The explanatory view showing the example of installation of the mask member in said examples 4 and 8 of a configuration (two kinds).
[Drawing 10] (A) and (B) -- the sectional view showing the laminating mold liquid crystal display component which is the 3rd operation gestalt, respectively.
[Drawing 11] The explanatory view showing the electric field generated with the electrode for horizontal electric-field impression.
[Description of Notations]
11 21 -- Substrate
12a, 12b, 22a, 22b, 23 -- Electrode
31 -- Substrate
32 -- Mask member
E1 -- Horizontal electric field

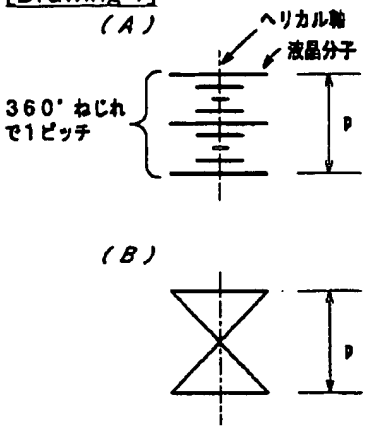
[Translation done.]

* NOTICES *

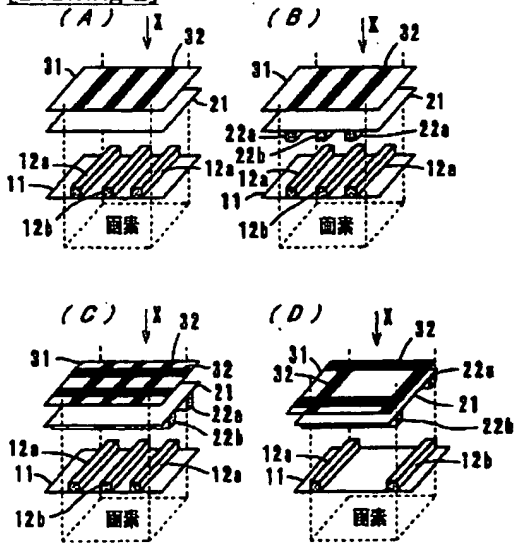
JPO and INPIT are not responsible for any
damages caused by the use of this translation.

DRAWINGS

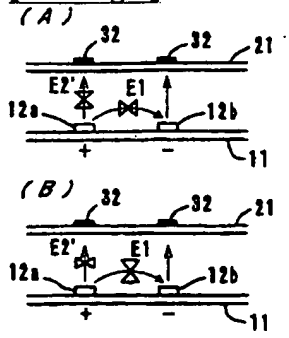
[Drawing 1]



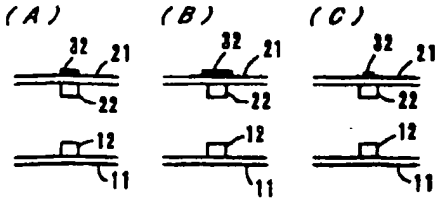
[Drawing 2]



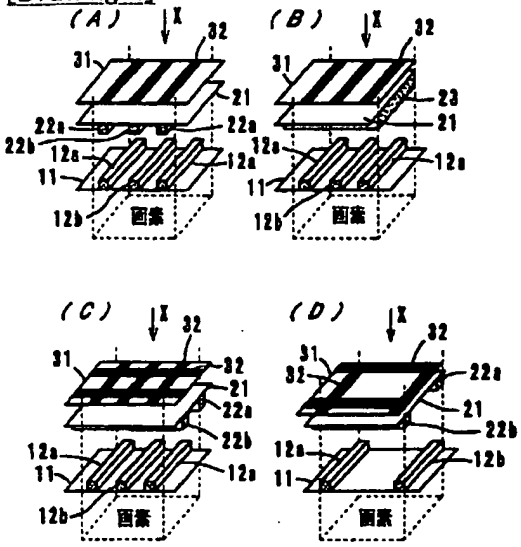
[Drawing 3]



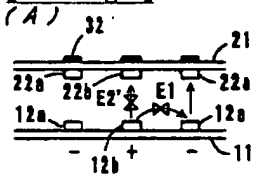
[Drawing 8]



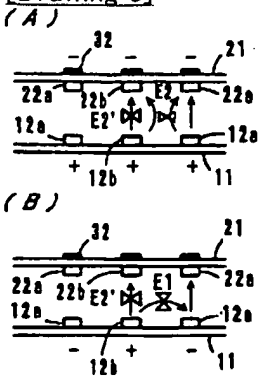
[Drawing 4]



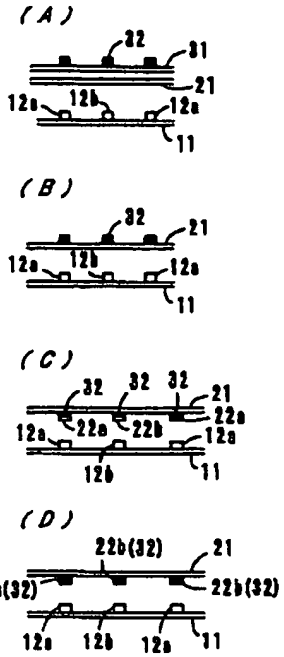
[Drawing 5]



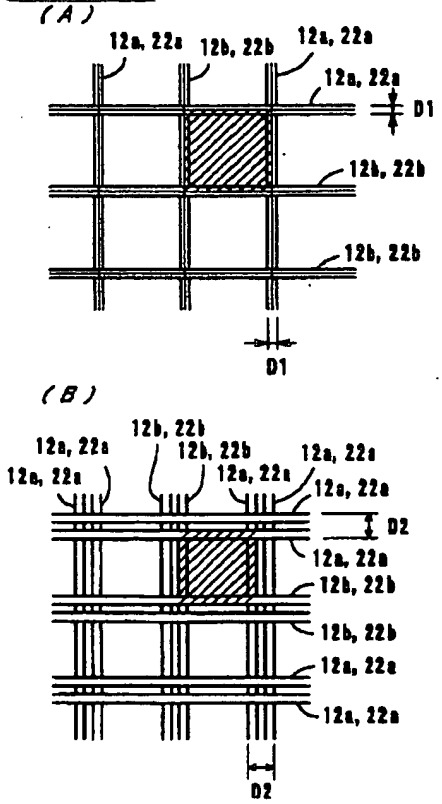
[Drawing 6]



[Drawing 7]

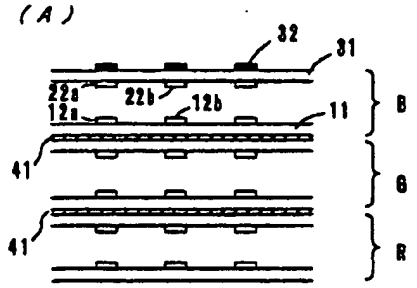


[Drawing 9]

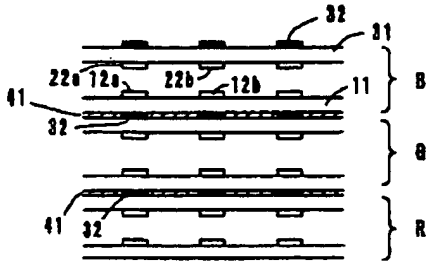


[Drawing 10]

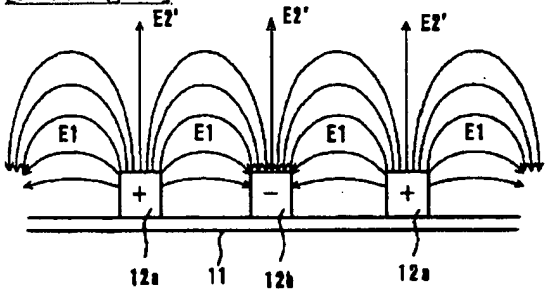
(A)



(B)



[Drawing 11]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2003－215613
（P2003－215613A）
(43)公開日　平成15年７月30日(2003.7.30)

(51)Int.Cl.'	識別記号	ＦＩ		テーマコード'（参考）
Ｇ０２Ｆ　1/1343		Ｇ０２Ｆ	1/1343	２Ｈ０８８
1/137			1/137	２Ｈ０９２

審査請求　未請求　請求項の数５　ＯＬ　（全８頁）

(21)出願番号　特願2002－9224(P2002－9224)

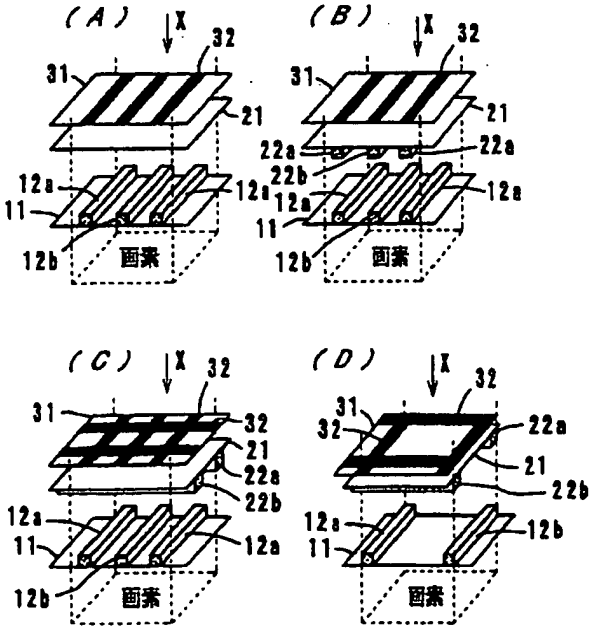
(22)出願日　平成14年１月17日(2002.1.17)

(71)出願人　000006079
ミノルタ株式会社
大阪府大阪市中央区安土町二丁目３番13号
大阪国際ビル
(72)発明者　越智　圭三
大阪府大阪市中央区安土町二丁目３番13号
大阪国際ビル　ミノルタ株式会社内
(74)代理人　100091432
弁理士　森下　武一

Ｆターム(参考)　2H088 GA02 GA03 GA17 HA02 JA14
MA02 MA06
2H092 GA14 HA02 NA01 QA11

(54)【発明の名称】　液晶表示素子

(57)【要約】
【課題】　横電界を印加するための電極の上方に付随的に発生する縦電界による液晶の不要な状態が表示に寄与しないようにして画質の劣化を極力排除することのできる液晶表示素子を得る。
【解決手段】　一対の基板１１，２１間にコレステリック相を示す液晶を挟持し、電極１２ａ，１２ｂ間及び／又は電極２２ａ，２２ｂ間に横電界（又は縦電界）を印加することにより、液晶をフォーカルコニック状態又はプレーナ状態にセットし、画像を表示する液晶表示素子。それぞれの電極を表示面側で覆うマスク部材３２が設けられている。



1

【特許請求の範囲】

【請求項１】　一対の基板と、前記基板間に挟持され、マトリクス状に配置された複数の画素を構成するコレステリック相を示す液晶層と、

少なくとも一方の基板に設けた、基板面に沿う方向の横電界を印加するための電極と、

前記横電界印加用電極を表示面側で覆うマスク部材と、を備えたことを特徴とする液晶表示素子。

【請求項２】　前記横電界印加用電極が複数の電極からなるか又は複数に分岐した分岐電極部を有しており、前記マスク部材は前記複数の電極又は分岐電極部のそれぞれに対応して設けられていることを特徴とする請求項１記載の液晶表示素子。

【請求項３】　前記横電界印加用電極は各画素の境界部に位置する部分を有しており、前記マスク部材は該画素境界部の電極部分に対応して設けられていることを特徴とする請求項１記載の液晶表示素子。

【請求項４】　前記マスク部材は、表示面側の基板上又は該基板の観察側に重ねられたいま一つの基板上に設けられていることを特徴とする請求項１、請求項２又は請求項３記載の液晶表示素子。

【請求項５】　前記基板間に挟持された液晶層が複数積層されており、少なくとも一つの液晶層について該液晶層を挟持する基板のうち表示面側の基板上又は該基板の表示面側に重ねられたいま一つの基板上にマスク部材を設けたことを特徴とする請求項１、請求項２、請求項３又は請求項４記載の液晶表示素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、液晶表示素子、特に、一対の基板間にコレステリック相を示す液晶を挟持し、該液晶の選択反射を利用して表示を行う液晶表示素子に関する。

【０００２】

【従来技術と課題】従来、コレステリック液晶やコレステリック液晶相を示すカイラルネマチック液晶を一対の基板間に挟持し、基板面に対して平行方向の横電界を印加し、液晶の状態を変化させて表示を行う液晶表示素子が提案されている（例えば、特開平７－１２０７９２号公報、特開２００１－８３４８５号公報参照）。横電界の印加時に縦電界を重畳する例もある（特開２００１－１００２５６号公報参照）。

【０００３】ところで、横電界の印加によって液晶の状態（フォーカルコニック状態、プレーナ状態）を変化させて画像を表示するコレステリック液晶相を示す液晶を用いた従来の典型的な液晶表示素子においては、１画素ごとに独立して横電界を発生させるために、図１１に示すように、少なくとも一方の基板１１に配置される電極１２ａ，１２ｂを櫛歯状にしていた。

【０００４】この櫛歯状の電極１２ａ，１２ｂ間に電位

2

差を生じさせると横電界Ｅ１が発生するが、電極１２ａ，１２ｂの上方には基板面に対して垂直方向の縦電界Ｅ２'が付随的に発生して表示画像の品質を損なうという問題点を生じていた。例えば、横電界Ｅ１によって電極１２ａ，１２ｂ間の液晶をそのヘリカル軸が基板面に平行なフォーカルコニック状態にセットしているとき、電極１２ａ，１２ｂ上では液晶をフォーカルコニック状態にセットすることができず、不要な反射が発生してコントラストが低下するなど画質に悪影響を与えていた。

【０００５】そこで、本発明の目的は、横電界を印加するための電極の上方に付随的に発生する縦電界による液晶の不要な状態が表示に寄与しないようにして画質の劣化を極力排除することのできる液晶表示素子を提供することにある。

【０００６】

【発明の構成、作用及び効果】以上の目的を達成するため、本発明に係る液晶表示素子は、一対の基板と、該基板間に挟持され、マトリクス状に配置された複数の画素を構成するコレステリック相を示す液晶層と、少なくとも一方の基板に設けた、基板面に沿う方向の横電界を印加するための電極と、該横電界印加用電極を表示面側で覆うマスク部材とを備えたことを特徴とする。

【０００７】本発明に係る液晶表示素子においては、横電界印加用電極がマスク部材で覆われているため、該電極上に付随的に発生する縦電界による表示に不要な状態が表示面側で観察されることがなく、画質の劣化が防止される。

【０００８】本発明に係る液晶表示素子においては、横電界印加用電極を複数の電極で構成するか、複数に分岐した分岐電極部を有したものとし、前記マスク部材は前記複数の電極又は分岐電極部のそれぞれに対応して設けられていてもよいが、必ずしも全ての横電界印加用電極に対応して設けられている必要はない。また、横電界印加用電極を、各画素の境界部に位置する電極部分を有したものとし、マスク部材は該電極部分に対応して設けてもよい。横電界印加用電極を各画素の境界部のみに設けた上でマスク部材をこの境界部に設けた横電界印加用電極に対応して設けてもよい。

【０００９】マスク部材を設けることで画質の劣化を効果的に防止できるが、その反面、表示面開口率が低下するので表示輝度が若干低下することになる。従って、画質の劣化と画面の明るさを比較考慮してマスク部材を設ける横電界印加用電極を選定すればよい。また、マスク部材を各画素の境界部に位置する横電界印加用電極に対応して設ければ、画像表示において画素を分離する効果を発揮し、色のにじみやエッジ部のぼけなどが解消され、シャープな画像が得られる。

【００１０】また、マスク部材の幅は横電界印加用電極の幅と一致していてもよく、あるいは、横電界印加用電極の幅よりも広かったり、狭くなっていてもよい。横電

界印加用電極による電界の方向は電極幅と電極間隔に依存し、電界が縦になる領域も一律ではない。付随的に発生する縦電界による不要な状態を遮蔽すべき領域は、電極幅と一致する場合もあれば、電極幅よりも広い場合もあり、逆に狭い範囲を遮蔽すればよい場合もある。従って、マスク部材の幅はこの遮蔽すべき領域に応じて決定すればよい。さらに、マスク部材の幅は表示輝度との関係も考慮して決められる。

【００１１】さらに、マスク部材は表示面側の基板に設けてもよく、あるいは、表示面側の基板に重ねられたいま一つの基板上に設けてもよい。電極が表示面側の基板に設けられる場合、該電極がマスク部材を兼ねていてもよい。即ち、電極を不透明（例えば、黒色）とすることでマスク部材を兼用させることができる。

【００１２】それぞれが一対の基板間に挟持された複数の液晶層が積層され、少なくとも一つの液晶層について該液晶層を挟持する基板のうち表示面側の基板上又は該基板の表示面側に重ねられたいま一つの基板上にマスク部材を設けるようにしてもよい。この場合、少なくとも最も表示面側に位置する液晶層を挟持する基板の表示面側の基板上又は該基板の表示面側に重ねられたいま一つの基板上にマスク部材を設けることが好ましい。このようにすると、最も表示面側の液晶層の表示面側に設けたマスク部材により全ての液晶層についてマスクを行うことが可能となる。

【００１３】

【発明の実施の形態】以下、本発明に係る液晶表示素子の実施形態について、添付図面を参照して説明する。

【００１４】（駆動原理、図１参照）本発明に係る液晶表示素子は、種々の駆動原理に基づいて表示を行うものであり、その代表的な駆動原理として、縦横電界切換え方式とＩＰＳ（Ｉｎ－Ｐｌａｎｅ－Ｓｗｉｔｃｈｉｎｇ）方式の一つである横電界２周波駆動方式について説明する。

【００１５】縦横電界切換え方式は、縦電界を印加する手段及び横電界を印加する手段を備え、両者の切り換えによりコレステリック相を示す液晶（以下、カイラルネマチック液晶で代表する）のねじれを解くことなく、そのヘリカル軸を基板に対して所定の角度に、好ましくは、基板に対してほぼ垂直及びほぼ平行に変化させることにより表示を行うものであり、中間調は面積階調方式で表現する。一方で、縦横の電界の組合せによってヘリカル軸を任意の角度に傾ける方式もある。

【００１６】カイラルネマチック液晶はネマチック液晶に所定量のカイラル材を添加することによって得られる。このカイラルネマチック液晶は、図１（Ａ）に示すように、一般的に、棒状の液晶分子がねじれた配列をなし、コレステリック相を示している。この液晶に光が入射すると、ヘリカル軸に対して平行な方向から光が入射した場合、λ＝ｎｐで示される波長の光を選択反射する（ブレーナ状態）。ここで、λは波長、ｎは液晶分子の平均屈折率、ｐは液晶分子が３６０°ねじれている距離（以下、螺旋ピッチと記す）である。一方、ヘリカル軸に対して垂直な方向から光が入射した場合、原理的に光は透過される（フォーカルコニック状態）。この選択反射及び透過を利用して表示が行われる。なお、液晶のコレステリック相は図１（Ｂ）のようにも示される。

【００１７】ところで、液晶分子は棒状であるが、その長手方向（長軸）とそれに垂直な方向（短軸）で屈折率や誘電率が異なる異方性を有している。液晶分子の長軸方向の誘電率が短軸方向のそれよりも大きい液晶を誘電率異方性が正の液晶と称する。誘電率異方性が正の液晶に十分に高い電圧を印加するとねじれが解け、液晶分子の長軸（誘電率が大きい軸）が電界方向と平行な方向に向くように動く。このねじれが解ける電圧には閾値が存在し、この閾値電圧をＶｈとする。

【００１８】また、前記閾値電圧Ｖｈよりも低い電圧を液晶に印加すると、液晶はねじれを解くことなくヘリカル軸が電界方向に対して垂直な方向に向くように動く。このヘリカル軸を動かす電圧にも閾値が存在し、この閾値電圧をＶｆとする。

【００１９】これらの閾値電圧Ｖｈ，Ｖｆの関係は、Ｖｆ＜Ｖｈである。また、閾値電圧Ｖｆよりも低い電圧を液晶に印加しても液晶分子は動くことがない、即ち、ヘリカル軸方向が変化することがない。

【００２０】これに対して、液晶分子の長軸方向の誘電率が短軸方向のそれよりも小さい液晶を誘電率異方性が負の液晶と称する。誘電率異方性が負の液晶に十分に高い電圧を印加するとねじれを解くことなくヘリカル軸が電界方向とは関係なくランダムに向く。この現象はダイナミックスキャッタリングと称されている。この現象が起こる電圧には閾値が存在し、閾値電圧をＶｄとする。

【００２１】また、前記閾値電圧Ｖｄよりも低い電圧を液晶に印加すると、液晶はねじれを解くことなくヘリカル軸が電界方向に対して平行な方向に向くように動く。このヘリカル軸を動かす電圧にも閾値が存在し、この閾値電圧をＶｐとする。

【００２２】これらの閾値電圧Ｖｄ，Ｖｐの関係は、Ｖｐ＜Ｖｄである。また、閾値電圧Ｖｐよりも低い電圧を液晶に印加しても液晶分子は動くことがない、即ち、ヘリカル軸方向が変化することがない。

【００２３】なお、コレステリック相を示す液晶は、一般的に液晶分子の軸に対する屈折率の異方性と誘電率の異方性の方向が一致しており、誘電率異方性が正の液晶では液晶分子の長軸方向の屈折率が短軸方向のそれよりも大きく、誘電率異方性が負の液晶では液晶分子の長軸方向の屈折率が短軸方向のそれよりも小さいことが多い。

【００２４】一方、ＩＰＳ方式は、基板に対して平行な横電界を印加することによって表示を行う方式であり、

一例として横電界２周波駆動方式を説明する。

【００２５】即ち、コレステリック相を示すある種の液晶は、印加電界の周波数を高周波／低周波に切り換えることによって、誘電率異方性の正／負が切り換わるものが存在する。このような液晶に対しては印加電圧が横電界のみであってもその周波数を高周波と低周波に切り換えることによって、螺旋構造を完全に解くことなしにそのヘリカル軸の向きをかえることでき、各画素をフォーカルコニック状態又はプレーナ状態に選択的にセットし、画像を表示することができる。

【００２６】なお、カイラルネマティック液晶などのコレステリック相を示す液晶を用いることにより、表示状態を電圧印加停止後も維持できるように構成する（すなわち、メモリ性を有する表示素子とする）ことも可能である。メモリ性を有する表示素子の場合、素子のメモリ性を利用して所定時間静止画を表示させることが多い。静止画は動画に比べて色むらが視認されやすいと考えられるため、本発明の適用が特に効果的である。

【００２７】（第１実施形態、図２、図３参照）第１実施形態である液晶表示素子は、前記横電界２周波駆動方式によるものであり、図２（Ａ），（Ｂ），（Ｃ），（Ｄ）にその代表的な電極構成例１，２，３，４を示す。なお、図２に示す各素子においてはそれぞれ矢印Ｘ方向から画像を観察することになる。

【００２８】構成例１は、図２（Ａ）に示すように、下基板１１の上面側に横電界印加用の電極１２ａ，１２ｂを設け、上基板２１には電極が設けられていない。また、上基板２１の上面にいま一つの基板３１が重ねられ、この基板３１の上面には、電極１２ａ，１２ｂを表示面側で覆う位置にマスク部材３２が設けられている。

【００２９】なお、横電界印加用電極は、複数本の電極から構成されていてもよいし、例えば１本の電極を櫛歯状に形成するなどして、複数の分岐電極部に分岐させたものであってもよい。この点は後述する構成例２～８についても同様である。

【００３０】基板１１，２１の間には、コレステリック相を示す液晶が挟持されている。この種の液晶としては、室温でコレステリック相を示すものであれば、種々のものを使用することができる。典型的には、ネマチック液晶にカイラル材を添加し、室温でコレステリック液晶相を示すようにしたカイラルネマチック液晶が用いられる。この第１実施形態で使用される液晶は、電極１２ａ，１２ｂに印加する電界の周波数を高周波／低周波に切り換えることによって、誘電率異方性の正／負が切り換わるものである。

【００３１】基板１１，２１間のギャップを均一で一定に保持するために、必要に応じて、基板１１，２１間にスペーサ用の微粒子や、柱状又は壁状の樹脂構造物が配置される。また、下側の基板１１の裏面に可視光を吸収する光吸収層が設けられる。基板１１自体に可視光吸収機能を持たせてもよい。さらに、基板１１，２１の液晶層と接する面には配向制御膜及び／又は絶縁膜が形成されていてもよい。

【００３２】基板１１，２１，３１の材料は、ガラスやポリエーテルスルフォン、ポリエチレンテレフタレート、ポリカーボネート等のプラスチックフィルムなど種々のものを使用できる。軽量で薄いものが好ましい。電極の材料は、ＩＴＯ、ＩＺＯ等の透明電極材料を使用でき、下基板１１の電極１２ａ，１２ｂはＡｌ，Ｃｕ等の非透明電極材料を使用してもよい。電極１２ａ，１２ｂは絶縁膜（図示せず）を介して２段に配置してもよい。

【００３３】マスク部材３２の材料は遮光性を有する膜を形成できるものであればよく、暗色、特に黒色の膜を形成できるものがコントラスト低下防止の観点から好ましい。例えば、クロム、ニッケル、アルミ、タングステン等の金属や金属酸化物膜、前記金属膜及び前記金属酸化物膜の積層膜、カーボンやチタン等の遮光剤をアクリル系樹脂などの樹脂中に分散してなる樹脂膜、黒色感光性レジスト膜などを使用することができる。観察者の好み等に合わせて黒以外の色を持つものや光反射性の材料でマスク部材を構成してもよい。

【００３４】金属や金属酸化物膜を用いる場合、フォトリソ法などを用いてパターン状にエッチングする方法により所望パターンのマスク部材を形成することができる。遮光剤を分散した樹脂膜を用いる場合、インクジェット法などの印刷法により所定パターンに印刷する方法で所望パターンのマスク部材を形成することができる。黒色感光性レジスト膜を用いる場合、フォトリソ法により不要部分を除去することで所望パターンのマスク部材を形成することができる。

【００３５】構成例１においては、図３（Ａ）（図３では簡略化のために基板３１は図示せず）に示すように、電極１２ａ，１２ｂに異なる極性の電圧を印加し、例えば、低周波の横電界Ｅ１を発生させると、誘電率異方性が負の液晶はそのヘリカル軸が横電界Ｅ１と同じ方向を向くフォーカルコニック状態になる。しかし、電極１２ａ，１２ｂ上には縦電界Ｅ２’しか発生しないため、この領域の液晶はヘリカル軸が縦電界Ｅ２’と同じ方向を向くプレーナ状態になる。

【００３６】一方、電極１２ａ，１２ｂ間に高周波の横電界Ｅ１を発生させると、該液晶は誘電率異方性が正に変化し、図３（Ｂ）に示すように、螺旋構造を完全に解くことなしにヘリカル軸が横電界Ｅ１に垂直な方向を向くプレーナ状態になる。しかし、電極１２ａ，１２ｂ上には縦電界Ｅ２’しか発生しないため、この領域の液晶はヘリカル軸が縦電界Ｅ２’に垂直な方向を向くフォーカルコニック状態になる。

【００３７】このように、電極１２ａ，１２ｂの上方では縦電界Ｅ２’しか発生しないため、電極１２ａ，１２ｂ間の画素を構成する液晶とは逆の状態となり、これが

表示面に反映されると画質を劣化させる。構成例１では、画質を劣化させる電極１２ａ，１２ｂ上の領域をマスク部材３２で覆っているため、画素とは逆の状態にある領域が観察者に対して遮蔽され、画質の劣化が防止される。

【００３８】構成例２は、図２（Ｂ）に示すように、上基板２１の下面側にも電極２２ａ，２２ｂを、下基板１１の電極１２ａ，１２ｂと対向した位置に設けたものである。他の構成、液晶を横電界２周波駆動方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例１と同様である。

【００３９】構成例３は、図２（Ｃ）に示すように、上基板２１の下面側に電極２２ａ，２２ｂを、下基板１１の電極１２ａ，１２ｂと直交する方向に設けたものである。マスク部材３２は電極１２ａ，１２ｂ，２２ａ，２２ｂのそれぞれを覆うように設けられている。他の構成、液晶を横電界２周波駆動方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例１と同様である。

【００４０】なお、図２（Ａ）～（Ｃ）においては、理解を容易にするために画素内に配置される電極の本数を２～３本としているが、この本数は任意であり３本以上としてもよい。

【００４１】構成例４は、図２（Ｄ）に示すように、下基板１１の上面側及び上基板２１の下面側に、互いに直交する電極１２ａ，１２ｂ，２２ａ，２２ｂを画素の境界部にのみ設けたものである。マスク部材３２は電極１２ａ，１２ｂ，２２ａ，２２ｂのそれぞれを覆うように設けられている。他の構成、液晶を横電界２周波駆動方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例１と同様である。

【００４２】特に、構成例４では、電極１２ａ，１２ｂ，２２ａ，２２ｂを各画素の境界部に設置し、マスク部材３２をこれらの電極に対応して設けたため、画像表示において画素を分離する効果を発揮し、色のにじみやエッジ部のぼけなどが解消され、シャープな画像が得られる。また、マスク部材３２によって表示輝度が低下する度合が減少する。

【００４３】なお、構成例２～４においては、上基板２１上に設けた電極２２ａ，２２ｂに横電界を発生させる電圧を印加することで、液晶層に対してより効果的に横電界を作用させることができるが、電極２２ａ，２２ｂに電圧を印加せず下基板１１上の電極のみに電圧を印加して表示を行うことも可能である。

【００４４】（第２実施形態、図４～図６参照）第２実施形態である液晶表示素子は、前記縦横電界切換え方式によるものであり、図４（Ａ），（Ｂ），（Ｃ），（Ｄ）にその代表的な電極構成例５，６，７，８を示す。なお、図４に示す各素子においてはそれぞれ矢印Ｘ方向から画像を観察することになる。

【００４５】構成例５は、図４（Ａ）に示すように、下基板１１の上面側と上基板２１の下面側とに縦電界及び横電界を印加するための電極１２ａ，１２ｂ，２２ａ，２２ｂを互いに対向させて設けたものである。上基板２１の上面に重ねて設けたいま一つの基板３１の上面には、電極１２ａ，１２ｂ，２２ａ，２２ｂを表示面側で覆うマスク部材３２が設けられている。

【００４６】基板１１，２１間に挟持されたコレステリック相を示す液晶は誘電率異方性が負又は正を示すカイラルネマチック液晶が用いられている。この第２実施形態で使用される液晶は、横電界又は縦電界を選択的に印加することにより、そのヘリカル軸が所定の方向を向いてフォーカルコニック状態又はプレーナ状態になり、画像を表示する。

【００４７】なお、基板１１，２１，３１やマスク部材３２の材質や形成方法等は前記第１実施形態で説明したものと同様である。

【００４８】構成例５において、負の誘電率異方性を有するカイラルネマチック液晶にあっては、そのヘリカル軸が電界方向に対して平行になるように動くため、基板１１に設けた電極１２ａ，１２ｂの間に（必要に応じて電極２２ａ，２２ｂの間にも）Ｖｄより低くＶｐ以上の電圧差を生じるように駆動すると、図５（Ａ）（図５，図６では簡略化のために基板３１は図示せず）に示すように、基板面に平行な横電界Ｅ１が発生し、液晶はそのヘリカル軸が基板面にほぼ平行な方向に向くフォーカルコニック状態になる。しかし、電極１２ａ，１２ｂ上には縦電界Ｅ２’しか発生しないため、この領域の液晶はヘリカル軸が縦電界Ｅ２’と同じ方向を向くプレーナ状態になる。

【００４９】一方、図５（Ｂ）に示すように、電極１２ａ，２２ａの間及び電極１２ｂ，２２ｂの間にＶｄより低くＶｐ以上の電圧差を生じるように駆動すると、基板面に垂直な縦電界Ｅ２が発生し、液晶はそのヘリカル軸が基板面に垂直な方向に向くプレーナ状態になる。また、電極１２ａ，１２ｂ上にも縦電界Ｅ２’が発生し、この領域の液晶もプレーナ状態になる。

【００５０】また、正の誘電率異方性を有するカイラルネマチック液晶にあっては、そのヘリカル軸が電界方向に対して垂直になるように動くため、電極１２ａ，２２ａの間及び電極１２ｂ，２２ｂの間にＶｈより低くＶｆ以上の電圧差を生じるように駆動すると、図６（Ａ）に示すように、基板面に垂直な縦電界Ｅ２が発生し、液晶はそのヘリカル軸が基板面に平行な方向に向き、フォーカルコニック状態になる。また、電極１２ａ，１２ｂ上にも縦電界Ｅ２’が発生し、この領域の液晶もフォーカルコニック状態になる。

【００５１】一方、電極１２ａ，１２ｂの間に（必要に応じて電極２２ａ，２２ｂの間にも）Ｖｈより低くＶｆ以上の電圧差を生じるように駆動すると、基板面に平行

な横電界Ｅ１が発生し、液晶はそのヘリカル軸が基板面にほぼ垂直な方向に向き、プレーナ状態になる。しかし、電極１２ａ，１２ｂ上には縦電界Ｅ２'しか発生しないため、この領域の液晶はヘリカル軸が縦電界Ｅ２'に垂直な方向を向くフォーカルコニック状態になる。

【００５２】このように、電極１２ａ，１２ｂの上方では、縦電界Ｅ２'しか発生しないため、誘電率異方性が負の液晶にあってはプレーナ状態に固定されたままであり、誘電率異方性が正の液晶にあってはフォーカルコニック状態に固定されたままである。即ち、電極１２ａ，１２ｂの上方の液晶はその状態を制御することができず、画質を劣化させる。構成例５では、画質を劣化させる電極１２ａ，１２ｂ上の領域をマスク部材３２で覆っているため、画素とは逆の状態にある領域が観察者に対して遮蔽され、画質の劣化が防止される。

【００５３】構成例６は、図４（Ｂ）に示すように、下基板１１上の電極１２ａ，１２ｂに対して上基板２１に画素の全面に対応する面状の電極２３を設けたものである。他の構成、誘電率異方性が正又は負の液晶を縦横電界切換え方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例５と同様である。

【００５４】構成例７は、図４（Ｃ）に示すように、上基板２１の下面側に電極２２ａ，２２ｂを、下基板１１の電極１２ａ，１２ｂと直交する方向に設けたものである。マスク部材３２は電極１２ａ，１２ｂ，２２ａ，２２ｂのそれぞれを覆うように設けられている。他の構成、誘電率異方性が正又は負の液晶を縦横電界切換え方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例５と同様である。

【００５５】なお、図４（Ａ）～（Ｃ）においては、理解を容易にするために画素内に配置される電極１２，２２の本数を２～３本としているが、この本数は任意であり３本以上としてもよい。

【００５６】構成例８は、図４（Ｄ）に示すように、下基板１１の上面側及び上基板２１の下面側に、互いに直交する電極１２ａ，１２ｂ，２２ａ，２２ｂを画素の境界部にのみ設けたものである。マスク部材３２は電極１２ａ，１２ｂ，２２ａ，２２ｂのそれぞれを覆うように設けられている。他の構成、誘電率異方性が正又は負の液晶を縦横電界切換え方式で駆動する態様、及び、マスク部材３２の作用効果は前記構成例５と同様である。また、各画素の境界部をマスクすることによる作用効果は前記構成例４で説明したとおりである。

【００５７】（マスク部材の設置位置、図７参照）ここで、マスク部材３２の設置位置に関して説明する。前記構成例１～８にあっては、上基板２１の上面に重ねて設けた基板３１にマスク部材３２を形成した例を示した。図７（Ａ）は構成例１の断面構成を示し、マスク部材３２は基板３１の上面に形成する以外に下面に形成してもよい。

【００５８】また、マスク部材３２は上基板２１の上面側に直接形成してもよい（図７（Ｂ）参照）。あるいは、マスク部材３２を上基板２１の下面側に形成し、その上に電極２２ａ，２２ｂを重ねて形成してもよい（図７（Ｃ）参照）。あるいは、上基板２１に形成される電極２２ａ，２２ｂを不透明なもの、例えば、光吸収機能を有するように黒色に着色したものとしてもよい（図７（Ｄ）参照）。

【００５９】なお、マスク部材３２は全ての電極に対応して設置される必要はない。例えば、前記構成例１，２，３，５，６，７において、１画素に対して並置された３本のマスク部材３２のうち中央の１本を省略してもよい。この場合は、表示輝度を優先させることになる。

【００６０】（マスク部材の幅、図８、図９参照）次に、マスク部材の幅と電極の幅との関係について説明する。一般的には、マスク部材３２の幅寸法を電極１２，２２の幅寸法と一致させればよい（図８（Ａ）参照）。但し、縦電界Ｅ２'が発生する領域は電極幅と電極間隔に依存し、一律ではない。従って、マスク部材３２の幅寸法は電極１２，２２の幅寸法よりも大きく設定したり（図８（Ｂ）参照）、小さく設定してもよい（図８（Ｃ）参照）。

【００６１】さらに、マスク部材３２は表示輝度の低下を招来するため、マスク部材３２の幅寸法は表示輝度との関係を考慮して狭く設定してもよい。

【００６２】前記構成例４，８の如く、電極１２ａ，１２ｂ，２２ａ，２２ｂを画素の境界部に設ける構成では、電極１２ａ，１２ｂ，２２ａ，２２ｂを、図９（Ａ）に示すように隣接画素の駆動に共用する場合と、図９（Ｂ）に示すように各画素ごとに設ける場合とがある。なお、図９（Ａ），（Ｂ）において斜線を付した領域が１画素を示している。

【００６３】図９（Ａ）に示す電極を共用する構成において、マスク部材の幅寸法は各電極の幅寸法Ｄ１を基準として決定される。一致する場合、広い場合、狭い場合があり得る。図９（Ｂ）に示す電極を独立させた構成において、マスク部材の幅寸法は隣接する電極及びその間の領域を含めた幅寸法Ｄ２を基準として決定すればよい。即ち、マスク部材は画素間領域を含めて電極を覆うことになる。

【００６４】（第３実施形態、図１０参照）図１０（Ａ）は、複数の液晶表示素子を積層した積層型液晶表示素子の要部断面図である。この表示素子では観察者側から順にＢ（青色）、Ｇ（緑色）、Ｒ（赤色）の選択反射を行う三つの表示素子を接着剤層４１を介して積層したものであり、フルカラー表示が可能である。図１０（Ａ）では、最も観察側に配置されるＢの選択反射を行う素子上にのみマスク部材３２を配している。このようにすると、最も表示面側のＢ素子に設けたマスク部材３２により全ての液晶層についてマスクの効果を及ぼすこ

とができ、構成が簡単である。

【００６５】図１０（Ｂ）は、積層型液晶表示素子において、各素子にそれぞれマスク部材３２を設けた例である。製造過程で素子の積層がずれたとしても、このずれによる表示劣化部分が生じない。上側素子の下基板上の電極を不透明にすることで下素子のマスク部材を兼ねるようにしてもよい。

【００６６】なお、素子の積層形態は前記のものに限らず、種々の形態を採用できる。例えば、四つ以上の素子を積層してもよいし、任意の波長の選択反射を行う表示素子を２層に積層したものでもよい。

【００６７】（他の実施形態）なお、本発明に係る液晶表示素子は前記各実施形態に限定するものではなく、その要旨の範囲内で種々に変更することができる。

【００６８】特に、前記実施形態では単純マトリクス型の液晶表示素子を例に挙げているが、画素ごとにスイッチング素子（例えば、ＴＦＴ：Thin Film Transistorや、ＴＦＤ：Thin Film Diode）を有するアクティブマトリクス型の液晶表示素子においても横電界を発生させて表示を行うものであれば本発明を適用できる。

【図面の簡単な説明】

【図１】液晶の動作原理を示す説明図。

【図２】第１実施形態である液晶表示素子の電極構成例１～４を示す斜視図。

【図３】前記構成例１における液晶の動作説明図で、（Ａ）はフォーカルコニック状態を選択した場合、（Ｂ）はプレーナ状態を選択した場合を示す。

＊【図４】第２実施形態である液晶表示素子の電極構成例５～８を示す斜視図。

【図５】前記構成例５における負の誘電率異方性を有する液晶の動作説明図で、（Ａ）はフォーカルコニック状態を選択した場合、（Ｂ）はプレーナ状態を選択した場合を示す。

【図６】前記構成例５における正の誘電率異方性を有する液晶の動作説明図で、（Ａ）はフォーカルコニック状態を選択した場合、（Ｂ）はプレーナ状態を選択した場合を示す。

【図７】マスク部材の設置位置（４種類）を示す説明図。

【図８】マスク部材の幅と電極の幅との関係（３種類）を示す説明図。

【図９】前記構成例４，８におけるマスク部材の設置例（２種類）を示す説明図。

【図１０】（Ａ），（Ｂ）それぞれ第３実施形態である積層型液晶表示素子を示す断面図。

【図１１】横電界印加用電極にて発生する電界を示す説明図。

【符号の説明】

１１，２１…基板

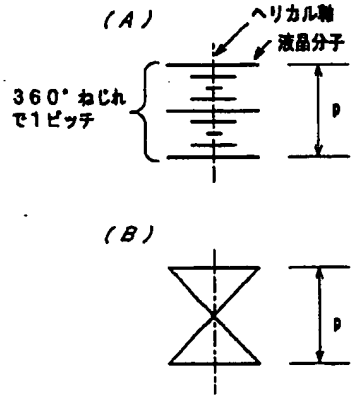
１２ａ，１２ｂ，２２ａ，２２ｂ，２３…電極

３１…基板

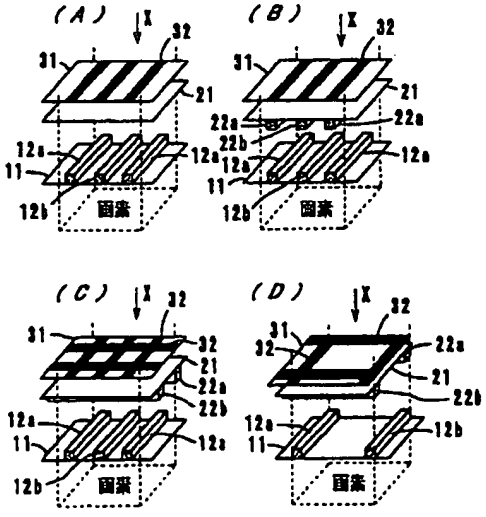
３２…マスク部材

Ｅ１…横電界

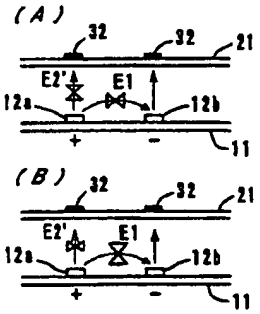
【図１】



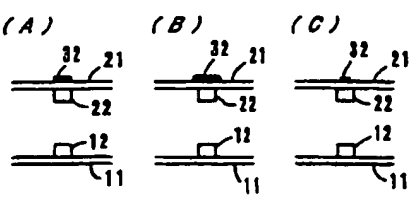
【図２】



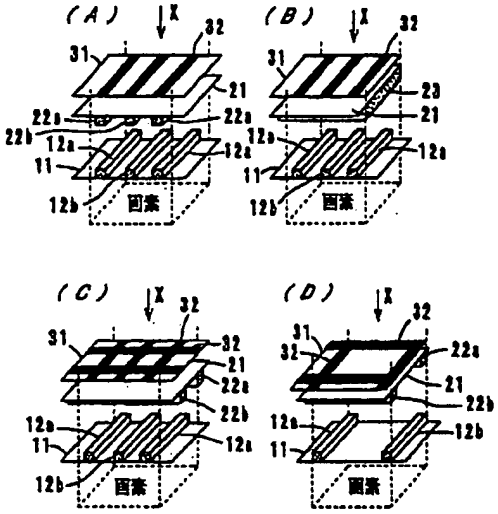
【図３】



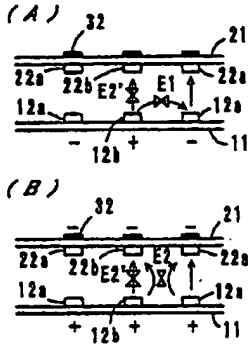
【図８】



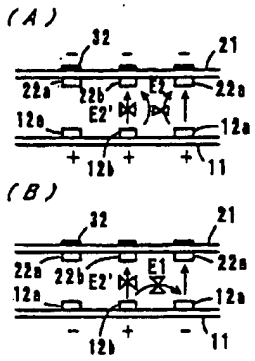
【図４】



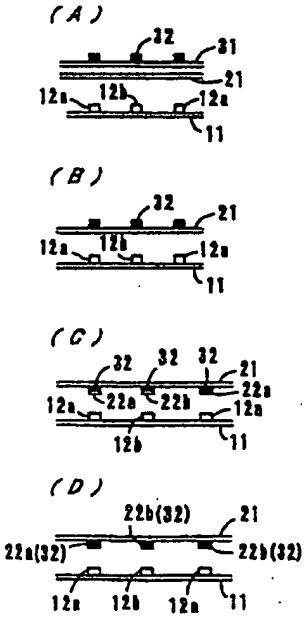
【図５】



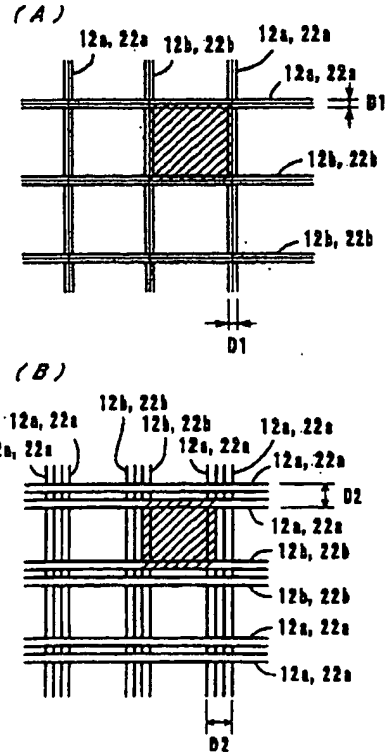
【図６】



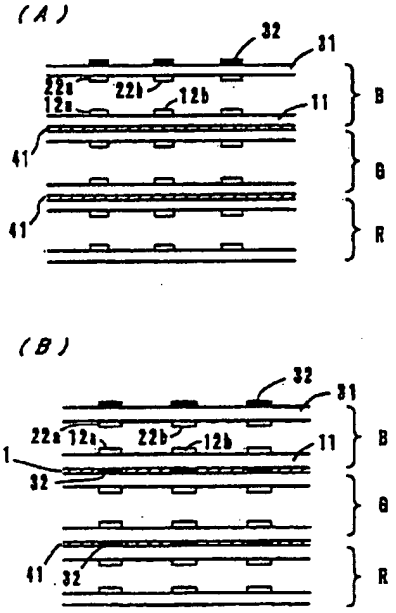
【図７】



【図９】



【図１０】



【図１１】